

PHILIPS



AC - MILLIVOLTMETER

PM 2454

9499 470 05811

1/172/2/06



PHILIPS

Manual

AC-MILLIVOLTMETER

PM2454

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9499 470 05811

1/172/2/06

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IMPORTANT

In correspondence concerning this instrument, please indicate the type number and serial number as given on the type plate at the rear of the instrument.

General

I. INTRODUCTION

The PHILIPS AC-Millivoltmeter PM 2454 is a sensitive and accurate measuring instrument suitable for measuring voltages from 50 μ V...300 V in the frequency range from 2 Hz...2 MHz

The instrument is fully transistorised (Silicon transistors), mains-powered and of modular construction. It can, therefore, be used both as a table model and in combination with other equipment mounted in standard racks.

A special feature of this AC-Millivoltmeter is its high input impedance of 10 M Ω /25 pF. On account of this it is also possible to measure voltages from high-ohmic sources.

The 12 measuring ranges of 1 mV...300 V f.s.d. overlap so that a high reading accuracy is obtained. The moving-coil instrument is provided with a mirror scale with the ranges 0-30 and 0-100 as well as a dB scale from -20 dB...+2 dB (total scale span -80 dB...+52 dB). The indicating speed can be switched from "FAST" to "SLOW", so that it is also possible to obtain a high reading accuracy at lower frequencies.

Due to its large bandwidth the instrument has wide range of applications, e.g. measurements on LF and IF amplifiers, carrier-wave telephony, infra and ultrasonics, etc.

The amplifier output, moreover, makes it possible to employ the instrument as a pre-amplifier for special purposes or may be used for connecting an oscilloscope.

II. TECHNICAL DATA

Tolerances: Numerical values with tolerances stated are guaranteed by the factory. Numerical values without tolerances serve merely for information and represent the properties of an average instrument.

A. ELECTRICAL

| | |
|--|--|
| Measuring range | 50 μ V...300 V divided into 12 ranges from 1 mV...300 V(f.s.d.) |
| dB Measuring range | -80 dB...+52 dB (12 ranges) 0 dB = 1 mW into 600 Ω , 0.775 V |
| Measuring accuracy | 10 Hz...300 kHz + 1 % of f.s.d. + 1 % of the reading Additional error at: 300 kHz...1 MHz + 1 % of f.s.d. 1 MHz...2 MHz and 2 Hz...10 Hz + 2 % of f.s.d. Switchable indication speed |
| Preliminary deflection | In position 1 mV < 25 μ V (with short-circuited input) |
| Input impedance | 10 M Ω /25 pF |
| Overload protection | For d.c. and frequencies < 100 Hz at all ranges : 300 Vrms For frequencies > 100 Hz Ranges 1 mV...1 V: 30 Vrms Ranges 3 V...300 V: 300 Vrms |
| Effect of mains voltage variations | A mains voltage variation of ± 15 % causes an additional measuring error of max. 0.2 % |
| Temperature range | + 15 $^{\circ}$ C...35 $^{\circ}$ C for the tolerances specified. Between 0 $^{\circ}$...15 $^{\circ}$ and 35 $^{\circ}$...50 $^{\circ}$ C a temperature coefficient of + 0.1 %/ $^{\circ}$ C should be taken into account. |
| Rectifying circuit for the meter section | Full-wave rms value rectifier |
| Meter scale | Mirror scale with knife-edge pointer. Calibrated in rms values of sinusoidal input voltages. Linear division from 0...103 and 0...32.5 dB-scale from -20 dB...+2 dB |

IV. BLOCK DIAGRAM (Fig. 1)

The voltage to be measured is applied to input attenuator I via input socket "INPUT". This attenuator is a capacitively compensated voltage divider, which effects an attenuation of 50 dB for all voltages from the 3 V range and upwards. For the lower ranges the input voltage is applied direct to the impedance matching stage.

Attenuator II is an ohmic voltage divider, which, in conjunction with attenuators I and III, divides the intermediate ranges into steps of 10 dB. The signal is now amplified by a factor 50 in a pre-amplifier and then applied to voltage divider III and from there to a second impedance matching stage. The latter consists of a double emitter-follower stage, so that the voltage divider is not influenced by the output amplifier.

The output of the second impedance stage is connected to output socket "AC OUTPUT" as well as to the amplifier and the rectifying circuit. In the feedback circuit of the multi-stage amplifier circuit a rectifier network has been included, which supplies the current for the meter. As the current in the feedback circuit is exactly proportional to the input voltage, the value indicated by the instrument will be equal to the value of the measuring voltage.

By means of switch "SLOW" the indicating speed of the meter can be reduced by including an additional capacitor, so that better reading is possible in the case of fluctuating measuring value indications.

The mains transformer is screened twice, whereby the screening of the primary windings are connected to the rim earthing contact of the mains input socket. Due to the very low capacitance of the primary winding with respect to the secondary winding and with respect to the housing, only negligibly small earth currents will arise. As a result the properties of the instrument will be practically the same as those of battery-operated instruments.

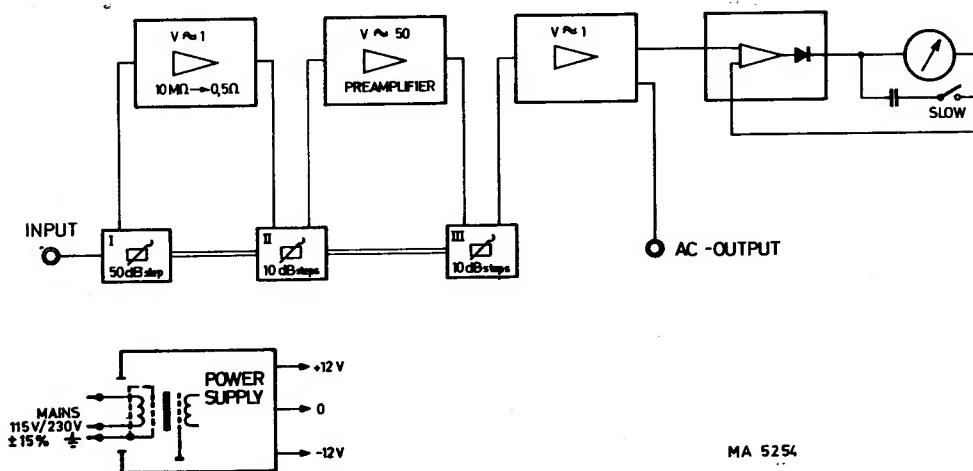


Fig. 1 Block diagram

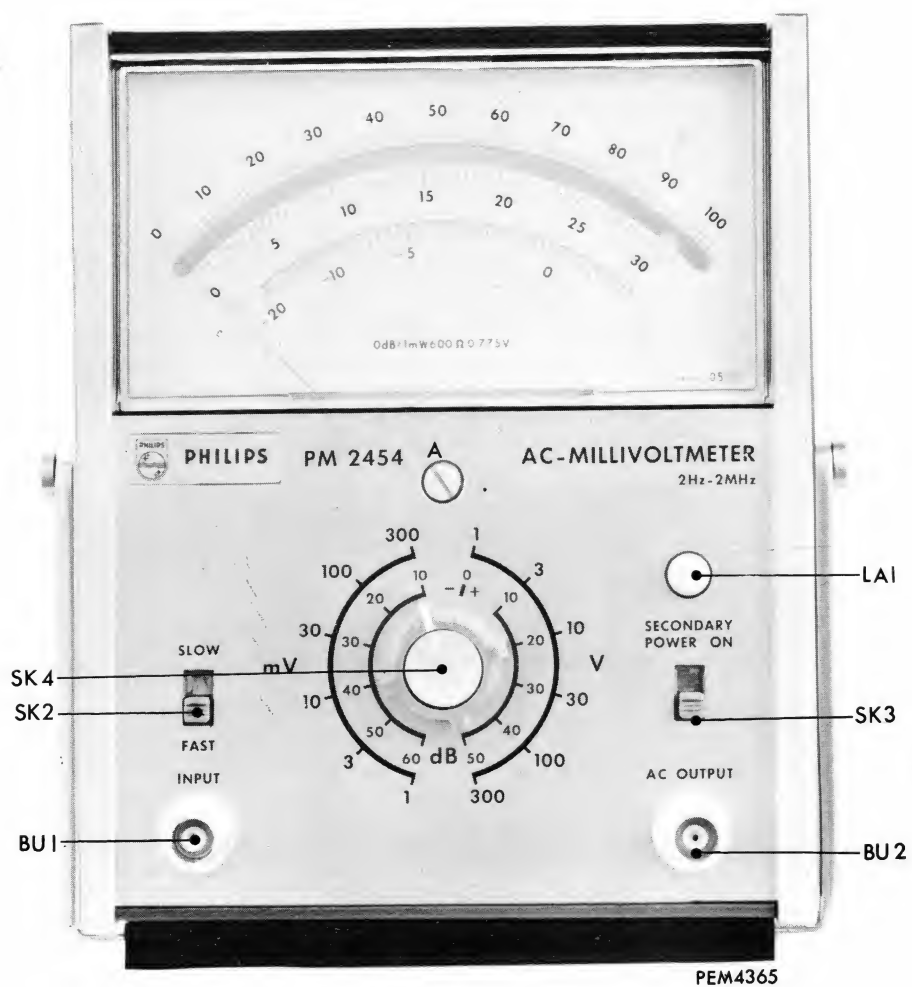


Fig. 3 Front view

VI. OPERATION (Fig. 3)

1. Mechanical zero setting

Place the instrument in a horizontal position and check the zero setting of the meter in the switched-off condition. If necessary, correct the setting by means of plastic screw A.

2. Switching-on

The primary side of the mains transformer is always connected to the mains. Therefore, the instrument has not been provided with a mains switch, but with a switch "SECONDARY POWER ON", which is included in the secondary circuit. The instrument is switched on by means of this switch after which the pilot lamp above the switch will light up.

3. Connecting the circuit under test

The voltage to be measured should be applied to coaxial socket "INPUT" (BU1). The high input impedance of $10\text{ M}\Omega/25\text{ pF}$ permits of carrying out measurements on very high-ohmic circuits. As the mains transformer of the instrument is screened twice, the capacitance between the instrument housing and the mains is very small (approx. 2 pF). As a result only very small earthing currents will arise, which can hardly effect the measurement.

4. Measuring at low frequencies

If it is not possible to obtain a proper reading due to pointer fluctuations at low frequencies, switch "SLOW-FAST" (SK2) should be set to position "SLOW". As a result the indicating speed of the meter will be reduced and the pointer deflection will become more stable.

5. Amplifier output

Coaxial socket "AC OUTPUT" (BU2) is an amplifier output. At full scale deflection of the meter (100 or 30 scale divisions) the output voltage on this socket is approx. 50 mV , independent of the selected range. The output is short-circuit proof. The output impedance is $600\ \Omega \pm 3\%$.

The waveform and phase of the output voltage correspond to the input voltage. The amplifier output is, therefore, extremely suitable for displaying the measuring signal by means of an oscilloscope. The instrument can also be used as a sensitive distortion free pre-amplifier or as an attenuator for high voltages, for more accurate evaluation of the output signal.

Directions for use

V. INSTALLATION

1. Adjusting to the local mains voltage (Fig. 2)

Before putting the instrument into operation, check that the value visible on the slide switch (SK1) at the rear corresponds to the local mains voltage.

- Mains voltages between 100 V and 132 V: 115 V setting
- Mains voltages between 200 V and 264 V: 230 V setting

The rating of fuse VL1 at the rear is 200 mA (delayed-action) for the complete voltage range from 100 V...264 V.

2. Earthing

The instrument should be connected to a socket with rim earthing contacts via the 3-core mains lead supplied.

For reasons of safety the housing of the instrument is connected direct^{*} to the rim earthing contact of the mains plug.

If only a socket without rim earthing is available the instrument should be earthed via socket BU3 at the rear.

^{*} Wire from earthing pin of mains plug to chassis.

3. Combining several units

On account of special construction of the housing, the instrument (2-module unit) can be combined with other instruments of the PHILIPS modular system



Fig. 2 Rear view

6. Selective voltage measurements

Selective voltages measurements can be carried out with the aid of an external filter. For the connection of this filter, see chapter VII, point D. For displaying selective signals (e.g. on an oscilloscope), a selective signal may be taken from output socket of the filter.

7. Errors due to distortion

Although the meter indicates the mean value of the full-wave rectified voltage, the scale of the instrument is calibrated in rms values of sinewave voltages. As a result measuring errors will arise when measuring non-sinusoidal voltages. The values of these depend on the coefficient of non-linear distortion. However, the voltmeter may be employed for comparative measurements of non-sinusoidal voltages with the same waveform. The measuring result may then differ from the value indicated by means of e.g. a thermo-couple voltmeter, which indicates the actual rms value.

Attention

At the rear of the instrument a hole has been provided for operating potentiometer R510 (see chapter X, point 4a). Because a very accurate calibration voltage is required, this potentiometer should only be readjusted in the case of re-calibration

Service data

VII. CIRCUIT DESCRIPTION (Fig. 19)

A. VOLTAGES RANGES

The 12 measuring ranges are determined by means of an attenuator consisting of three sections. The input attenuator (SK4/I) is a frequency-compensated voltage divider, which is operative in the measuring ranges from 3 V to 300 V. It causes an attenuation of the input voltage of 1:316.2; which corresponds to 50 dB. The attenuator can be adjusted by means of potentiometer R404 and trimmer C403. At the ranges 1 mV...1 V the input voltage is applied direct to the input stage.

Two other sections, II and III, are ohmic voltage dividers, which are connected between the amplifier stages in order to reduce the operating range of the amplifier and to obtain a low signal-to-noise ratio. The attenuation effected by the input voltage divider in conjunction with the attenuator stages is 10 dB per step. In other words, the first step is 0 dB and the highest step is 110 dB. The following table gives the sub-division relative to the switch sections. The total attenuation per stage is obtained by adding the attenuation of the individual attenuators.

| Measuring range | Attenuator SK4/I | Attenuator SK4/II | Attenuator SK4/III | Total attenuation |
|-----------------|---------------------|----------------------|-----------------------|----------------------|
| 1 mV | 0 dB | 0 dB | 0 dB | 0 dB |
| 3 mV | 0 dB | 0 dB | 10 dB | 10 dB |
| 10 mV | 0 dB | 0 dB | 20 dB | 20 dB |
| 30 mV | 0 dB | 10 dB | 20 dB | 30 dB |
| 100 mV | 0 dB | 20 dB | 20 dB | 40 dB |
| 300 mV | 0 dB | 20 dB | 30 dB | 50 dB |
| 1 V | 0 dB | 30 dB | 30 dB | 60 dB |
| 3 V | 50 dB | 0 dB | 20 dB | 70 dB |
| 10 V | 50 dB | 0 dB | 30 dB | 80 dB |
| 30 V | 50 dB | 10 dB | 30 dB | 90 dB |
| 100 V | 50 dB | 20 dB | 30 dB | 100 dB |
| 300 V | 50 dB | 30 dB | 30 dB | 110 dB |

B. IMPEDANCE MATCHING STAGE

This impedance matching stage is basically a 2-stage amplifier whose voltage is reduced to practically unity by means of negative feedback, (Fig. 4). The circuit is subjected to such a series-parallel feedback, that a stable amplification and a low output impedance are obtained thus compensating for temperature effects, and spread in tolerances. To protect field-effect transistor TS301, two silicon diodes GR301 and GR302 are connected in the reverse direction at the input. When the input voltage exceeds the supply voltage, the latter will flow off via the diodes and limit the drive voltage to 12 Vp-p. The output voltage is applied to intermediate attenuator SK4/II from R304 via C301, and then to the pre-amplifier.

C. PRE-AMPLIFIER

This circuit is a voltage amplifier consisting of TS303...TS307. It consists of 4 stages and has a gain factor of approx. 50 (Fig. 5). Series-parallel feedback ensures stable voltage amplification, a high input impedance and a low output impedance. The first amplifier stage is followed by an emitter-follower stage with TS305, which serves as an impedance matching and buffer stage. TS306 forms the second amplifier stage which is also connected to an emitter-follower (TS307). Zener diode GR303 serves for obtaining the proper working point. The output signal of TS307 is applied to attenuator SK4/III via C309 and is also fed back to the input stage via a frequency-dependent network and TS304. R314, C306, R313 and R312 + C304 in this feedback circuit serve for boosting the low frequencies. The high frequencies are boosted by R315, C308, C307 and Cx. These RC elements serve for extending the frequency characteristic at lower values, by compensation for the decline in frequency response, so that a larger bandwidth is obtained. The capacitance of Cx is very small and is adjusted by means of a piece of wire on the printed circuit board. TS304 is driven via the feedback circuit, whereby a feedback factor of 1 ensures stabilisation of the working point for d.c. voltages.

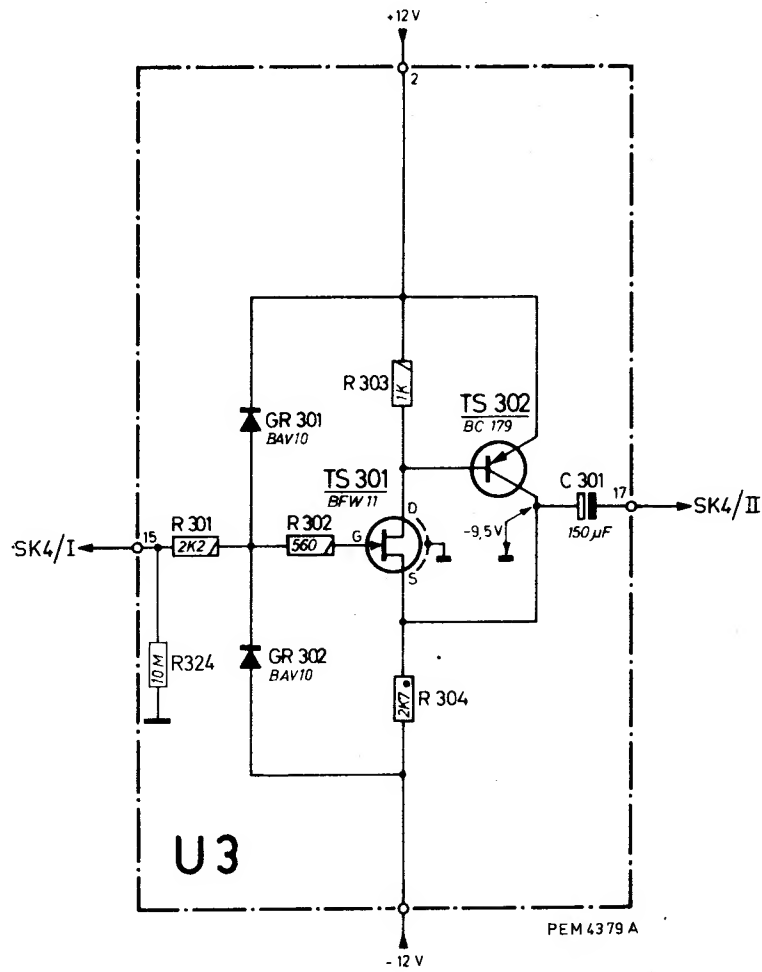


Fig. 4 Impedance matching stage

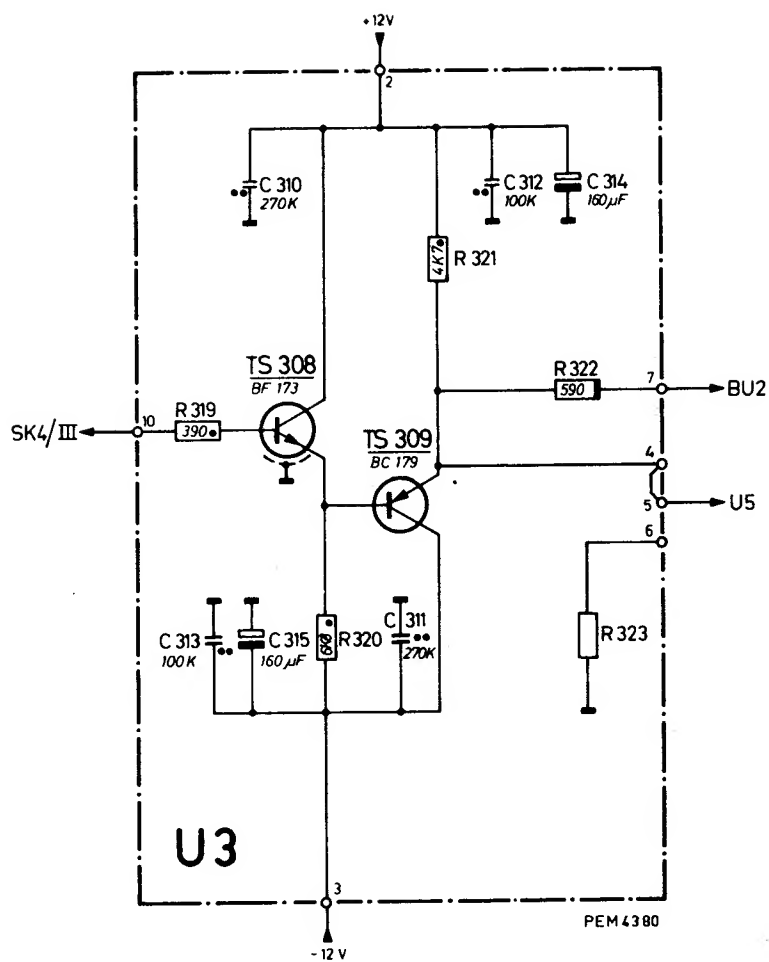


Fig. 6 Buffer stage

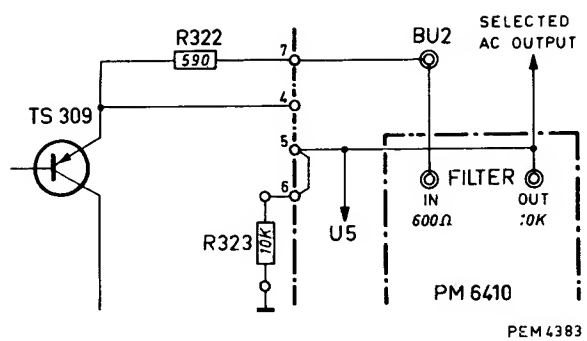


Fig. 7 Connecting octave filter PM 6410

D. BUFFER STAGE AND A. C. OUTPUT

After voltage divider SK4/III the measuring signal reaches a double emitter-follower, consisting of TS308 and TS309 (Fig. 6). The high impedance of this stage ensures that the voltage divider is not affected by variations in the input impedance. From the emitter of TS309 the output voltage is applied to meter circuit U5 and to output socket BU2 via R322.

Connecting an external filter (Fig. 7)

Between connection points 4, 5 and 6 an external filter may be connected for selective measurements. The short-circuit connection between U3/4 and U3/5 should then be soldered to points 5 and 6.

The external filter can then be connected to BU2 and to point U3/5.

Dependent on the filter employed a terminating resistor of suitable value should be fitted for R323. When the PHILIPS octave filter PM 6410 is used, the value of R323 is 10 k Ω .

E. METER CIRCUIT

The meter circuit (Fig. 8) serves converting an alternating voltage signal into an exactly proportional direct current. The indication corresponds to the rectified mean value of the input voltage, the scale being calibrated in rms values of sinusoidal voltages.

The rectifier network plus the meter are included in the feedback circuit. As the feedback current also flows through rectifier diodes GR501 and GR503, the knee voltages and the temperature dependence of these diodes are influenced so that stabilisation of the slope (ratio between the meter current and the input voltage) is achieved. A three-stage amplifier, consisting of TS501, TS502 and TS503, ensures a high no-load voltage gain, so that a linear indication is guaranteed. The working point of TS501 is stabilised by means of transistors TS505 and TS504.

In the case of a static current variation at TS501 (e.g. due to thermal effects) this variation is eliminated by means of TS502 and TS503. The voltage variation at resistor R514 drives TS505; the latter drives TS504, which corrects the setting (when TS501 becomes more conductive, TS504 becomes less conductive so that the base potential of TS502 remains constant). This control circuit is not operative for alternating voltages, as these are blocked by C511.

Zener diodes GR504 and GR505 serve for adapting the voltage potentials in the transistor circuit. GR506 ensures that the meter circuit is not overloaded. Choke L501 serves for maintaining the stability in case of oscillations which may occur in spite of the large bandwidth and the high amplification.

Potentiometer R510 can be employed for adjusting the meter to nominal value, and capacitor C508 can be included for conditionally increasing the time constant, with the aid of SK2.

F. POWER SUPPLY

Voltage stabilisation

The mains transformer supplies an alternating voltage of 47 V to Graetz rectifier GR201. The output direct voltage is divided in two independent voltage circuits, which have a common zero connected to the centre tap of T101. Both circuits comprise a stabilising circuit (Fig. 9). These stabilising circuit are not identical, one voltage circuit being positive and the other negative, but the working of both circuits is the same.

Therefore, only the positive voltage circuit is described. The pulsating direct voltage is applied to smoothing filter C201, R201 and C203.

Zener diode GR202 provides the reference voltage with which the output voltage taken from voltage divider R214, R215 and R218 is compared.

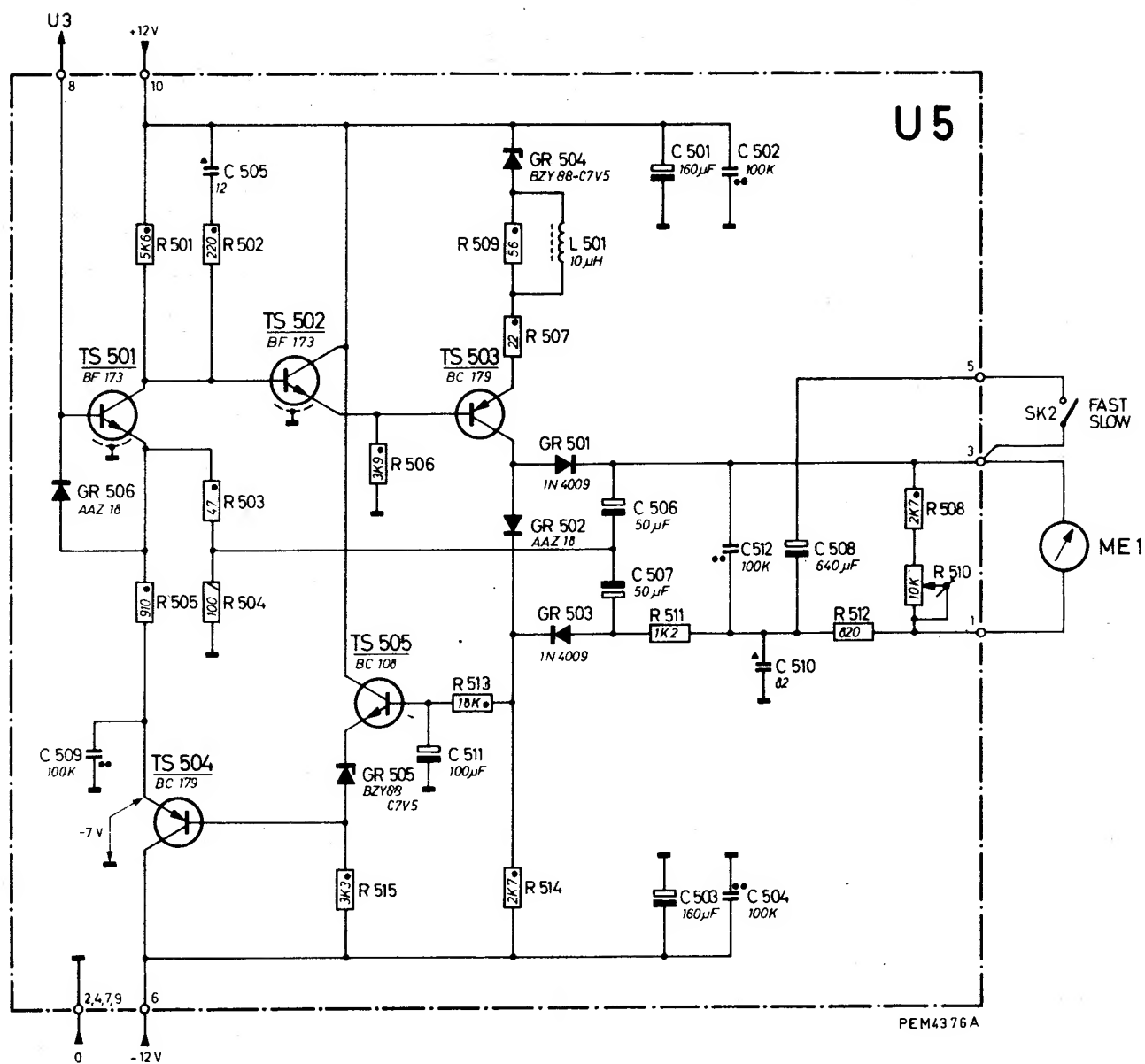


Fig. 8 Meter circuit

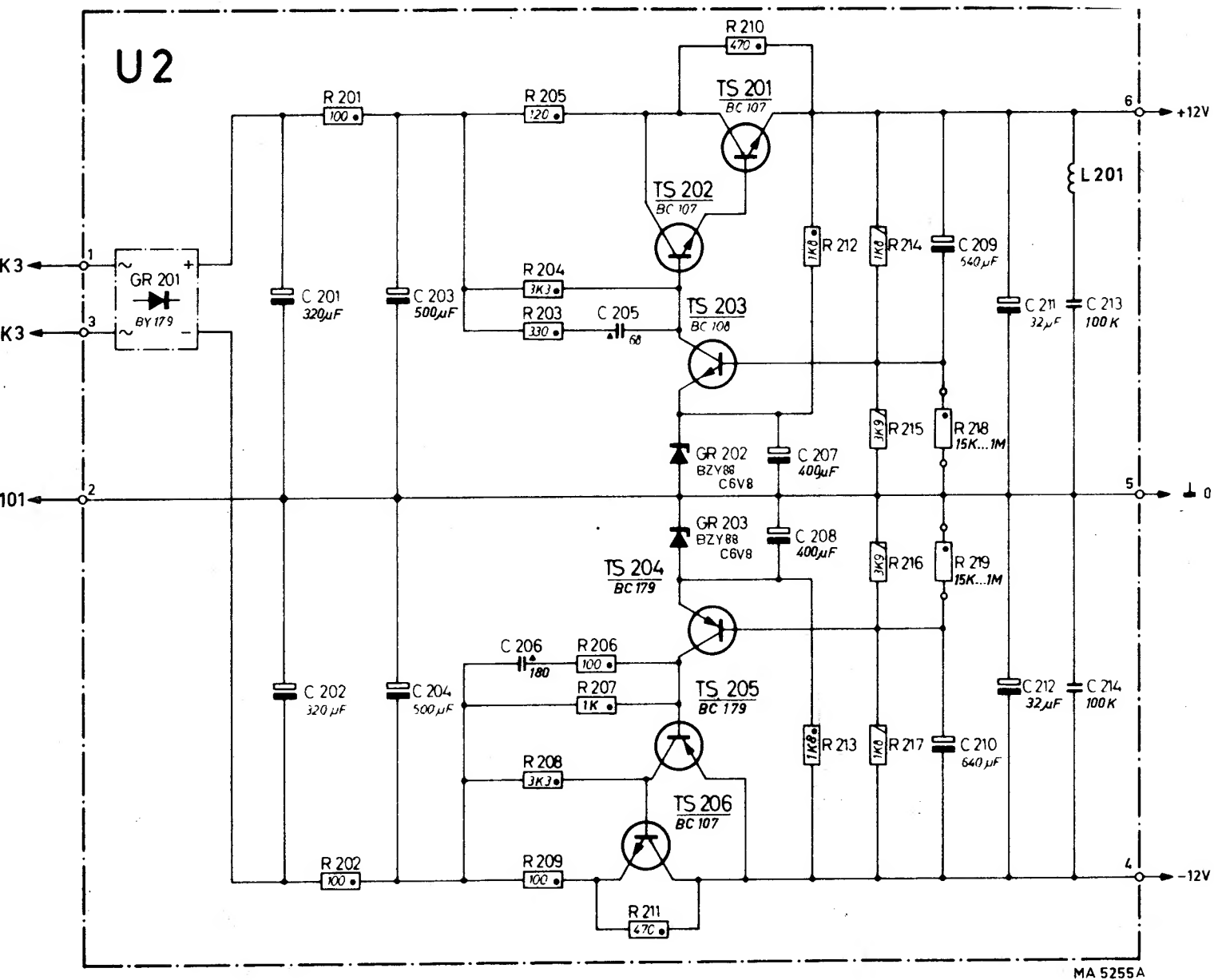


Fig. 9 Stabiliser circuit

The voltage difference then controls transistors TS203 and this, in turn controls emitter followers TS202 and TS201.

To prevent parasitic oscillations, RC circuit R203, C205 has been included for phase correction. The direct voltage is smoothed by means of C211 and C213; C213 serves for the suppression of superimposed HF voltages. L201 prevents high frequent oscillations. R218 serves for adjusting the output voltage.

Stabilisation:

In case of a load increase the voltage at the base of TS203 will drop slightly and so will the collector-emitter current. The base of TS202 will, therefore, become more positive and the collector emitter current will increase, so that the drive current of TS201 will also increase. On account of this the internal resistance of TS201 will become smaller and larger current will flow through the output circuit. The output voltage thus remains constant and will not deviate more than a small value of the control voltage difference.

VIII. GAINING ACCESS TO THE PARTS

1. Removing the cabinet (Fig. 10)

Top panel: Turn bayonet screw "A" at the rear of the instrument a quarter and slide the panel out in backward direction.

Tilting assembly:

- Move the small outermost nylon slides (pos. 29) inward
- Remove the tilting assembly

Side panels: Remove the two screws of the carrying handle, remove the bracket and lift the plates (which are slid into frame from the rear) slightly at the front and pull then out.

Bottom panel: Remove the tilting bracket by slightly compressing it at the corners and lifting it out of the guides. Remove screw "B" at the rear of the instrument and slide the bottom panel out in backward direction.

2. Printed circuit board

Printed circuit boards U2 (right-hand) and U3 (left-hand) can be tilted out sideways (Fig. 12-13). For this, remove the side panels and take out the printed circuit boards. Printed circuit board U5 at the rear of the instrument is accessible from the left and the right as well as from the bottom. For soldering operations the board should be taken out of the print holders and pressed slightly away from the chassis plate.

3. Range selector unit U4

For replacing one of the switch wafers of SK4, the complete unit should be removed; for this proceed as follows:

- Remove the bottom panel.
- Remove the knob of switch SK4, by prising off the knob cap and loosening the nut of the clamping cone.
- Unsolder all connection cables and their screens (observe the place of connections, if necessary, note them down! see Fig. 19).
- Remove the 4 screws "D" (Fig. 14); the complete range selector unit can now be taken out of the instrument after which the switch can be disassembled from the rear.

4. Measuring instrument

This can be removed as follows:

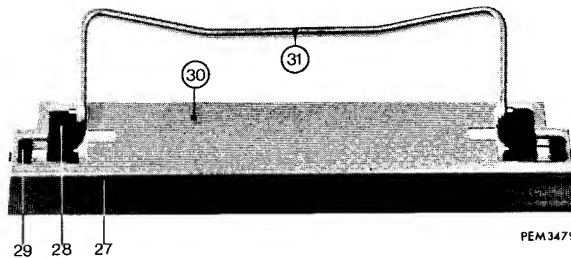
- Remove the top and side panels.
- Unsolder the connection cables with a small soldering iron (caution, the instrument housing is sensitive to heat!)
- Remove two screws "E" at each side of the instrument and loosen screw "F" on one side (Fig. 12-13).
- The relevant frame can be slightly pressed apart so that the instrument, together with the mounting plate, can be removed in forward direction.

5. Textplate

- Remove all cabinet panels.
- Remove the knob of switch SK4 (See point 3).
- Unsolder the connections from sockets BU1 and BU2 and from pilot lamp LA1.
- Remove the sockets and the lamp holder.
- Remove the rubber caps from the feet.
- Remove the two ornamental frames, by loosening the 4 grub screws "G" (Fig. 12-13) and the two screws "H" by means of which the relevant feet are secured.
- The text plate, which is glued to the chassis plate can be removed by means of a knife.

6. Pilot lamp LA1

This can be replaced after removal of the lens cap.



IX. MAINTENANCE

The PM 2454 comprises no components which are subject to substantial wear; the instrument therefore requires no maintenance.

The stator of range selector SK4 can be lubricated lightly with Molykote grease, when it shows excessive friction. It is advisable to use a thin fluid oil (or sewing machine oil) for the switch spindles.

In case of faults the switch contacts may only be treated with the special switch oil, specified in the list of parts.

In order to ensure the proper working of the instrument it should not be exposed to excessive moisture, heat, corrosion or dust.

X. CHECKING AND ADJUSTING

The tolerances mentioned are factory tolerances; they apply when the instrument is readjusted completely. They may differ from the data given in II. Adjustment should only be effected, if auxiliary equipment with the required tolerances are available.

1. Mechanical zero setting

With switched off instrument, check that the mechanical zero of the instrument pointer is correct. Deviations can be corrected by means of the setscrew. For this adjustment the instrument should be placed in a horizontal position.

2. Connection of the measuring instrument

For the following checks the measuring instrument should be supplied with nominal mains voltage, preferably via a variable transformer. The mains voltage should be checked by means of a voltmeter.

| Current consumption | Switched on | Switched off |
|---------------------|-------------|--------------|
| at 115 V | 34 mA | 2 - 6 mA |
| at 230 V | 17 mA | 1 - 3 mA |

3. Power supply

The supply voltages are +12 V and -12 V with respect to 0, tolerance ± 0.2 V.

| | |
|-------------|---|
| Test points | +12 V: U2/6 0 V: U2/5 -12 V: U2/4 |
| Adjustment | +12 V with R218 -12 V with R219 |

4. Adjustment the amplifier

a. Adjustment at low frequencies

- Apply a voltage of 10 mV or 100 mV ± 0.2 %, 400 Hz, to socket BU1.
- Set SK4 to 10 or 100 mV.
- Adjust the pointer of the meter to exactly 100 scale divisions by means of potentiometer R510.
Potentiometer R510 is accessible via a hole in the rear panel of the instrument (Fig. 11).
- Check all the other ranges from 1 mV...1 V.
- Set SK4 to 3 V or 10 V.
- Apply a voltage of 3 V or 10 V ± 2 %, 400 Hz, to BU1.
- Adjust the pointer deflection to exactly 30 or 100 scale divisions by means of potentiometer R404. For adjusting R404 the bottom panel should be removed (Fig. 14).
- Check the voltage on BU2; this should be 50 mV ± 10 %.
- Check all the other ranges from 3 V...300 V.

b. Adjustment at high frequencies.

- Apply a voltage of 10 mV or 100 mV $\pm 0.5\%$, 2 MHz, to BU1.
- Set SK4 to 10 mV or 100 mV.
- Adjust the pointer deflection to exactly 100 scale divisions by means of C307. C307 is accessible from the top of the instrument after removal of the top panel (Fig. 15) Trimmer C307 serves for fine adjustment. If its control range is not sufficient for adjustment to 100 scale divisions, circuit capacitance Cx on printed circuit board U3 should be corrected by reducing or extending the soldered-in wire.
- Check all the other ranges from 1 mV...1 V.
- Apply a voltage of 3 V or 10 V $\pm 0.5\%$, 2 MHz, to BU1.
- Set SK4 to 3 V or 10 V.
- Adjust the pointer deflection to exactly 30 or 100 scale divisions with C403.
- Trimmer C403 is located at the bottom of the instrument and is accessible after removal of the bottom panel (Fig. 14)
- Check all the other ranges from 3 V...300 V.

Remark

In case of breakdowns one can always apply to the world-wide PHILIPS Service Organisation.

Whenever it is desired to send the apparatus to a PHILIPS Service Centre for repair, the following points should be observed:

- tie on a label, bearing full name and address of the sender.
- indicate as complete as possible the symptom (s) of the fault (s)
- carefully pack the apparatus in the original packing, or, if no longer available, in a wooden crate.
- send the apparatus to the address provided by your local PHILIPS representative.

XI. LIST OF PARTS

A. MECHANICAL

| Fig. | Item | Qty | Ordering code | Description |
|---------|-------|--------|----------------|--|
| 13 | 1 | 4 | 4822 462 50101 | Foot |
| 13 | 2 | 4 | 4822 462 40157 | Rubber stud |
| 11 | 4 + 5 | 2 | 4822 460 60014 | Ornamental frame |
| 11 | 6 | 2 | 4822 460 60017 | Ornamental strip (6 modules) |
| 11 | 7a | 2 | 4822 310 10044 | Washer for handle bracket screw |
| 11 | 7b | 2 | | Handle bracket screw |
| 11 | 7c | 2 | | Handle bracket |
| 11 | 7d | 2 | | Screw for handle bar |
| 11 | 8 | 1 | 4822 134 40173 | Pilot lamp |
| 11 | 9 | 1 | 4822 455 90328 | Text plate |
| 10-11 | 10 | 3 | 4822 277 20014 | Slide switch (SK1-SK2-SK3) |
| 11 | 11 | 1 | 4822 273 84004 | Rotary switch (SK4) |
| 11 | 12 | 2 | 4822 267 10008 | BNC socket (BU1-BU2) |
| 11 | 13 | 1 | 4822 347 50024 | Meter (ME1) Sensitivity: 250 μ A Accuracy : 0.5 Ri . : 380 $\Omega \pm 20 \%$ |
| 11 | 14 | 1 | 4822 413 40112 | Knob, 23 mm dia |
| 11 | 15 | 1 | 4822 413 70037 | Knob cap, 23 mm dia |
| 10 | 16 | 1 | 4822 256 40026 | Fuse holder |
| 10 | 17 | 1 | 4822 265 30066 | Mains socket (CS1) |
| 12-13 | 18 | 8 | 4822 404 50254 | Printed circuit holder |
| 14 | 19 | 4 | 4822 693 40001 | Printed circuit holder |
| 11 | 20 | 1 | 4822 255 30042 | Lamp holder |
| page 28 | 28 | 2 | 4822 520 10182 | Bracket pivot |
| page 28 | 29 | 2 | 4822 462 70366 | Slide piece |
| page 28 | 30 | 1 | 4822 256 90086 | Strip holder |
| - | - | 1 | 4822 321 10071 | Mains lead |
| - | - | 30 cc. | 4822 390 10007 | Bottle of switch oil |

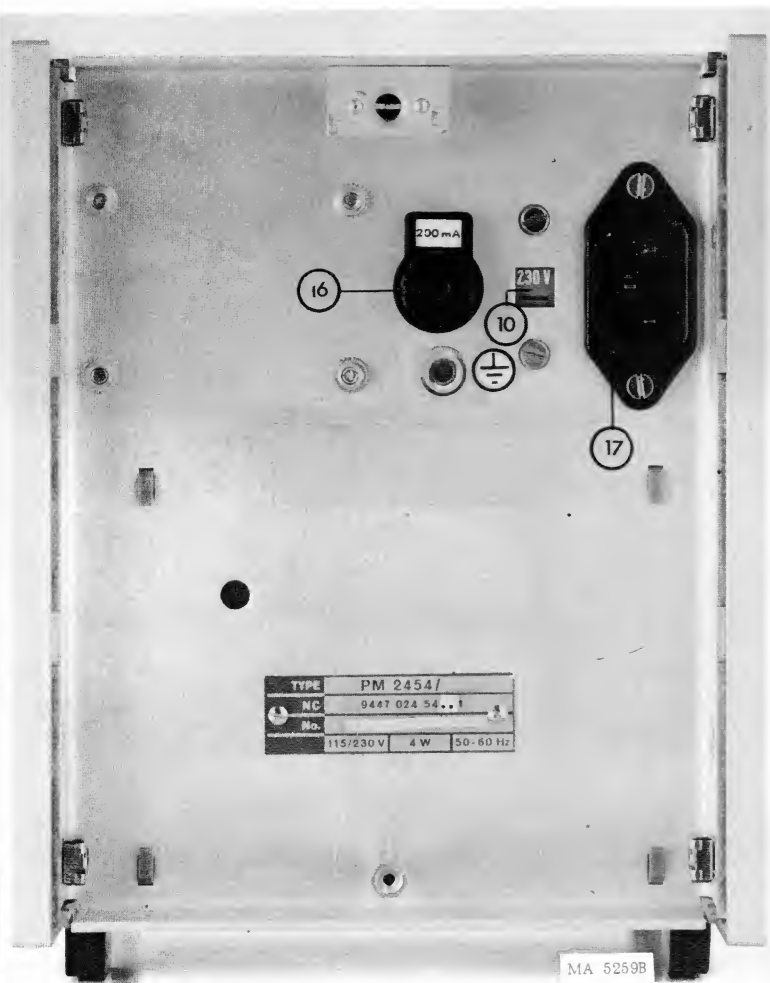


Fig. 10 Rear side

F

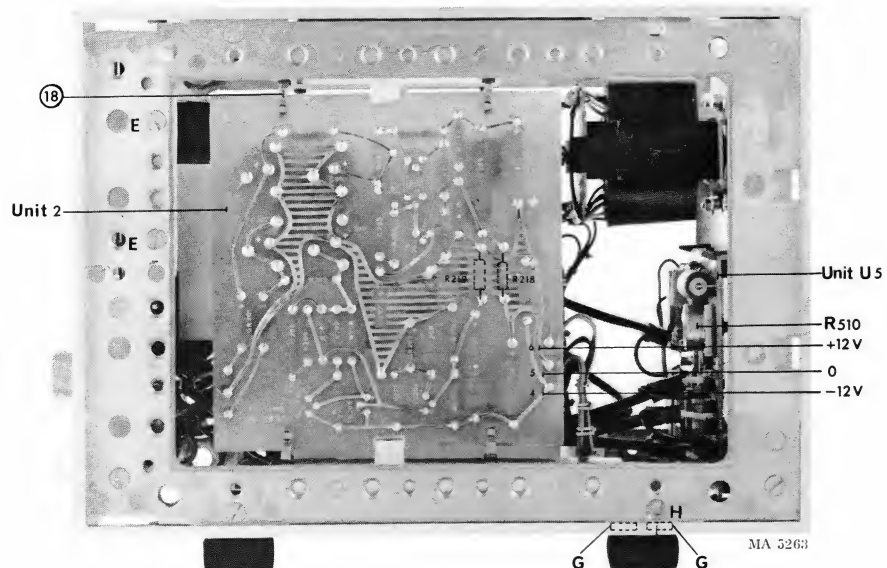


Fig. 12 Right-hand view

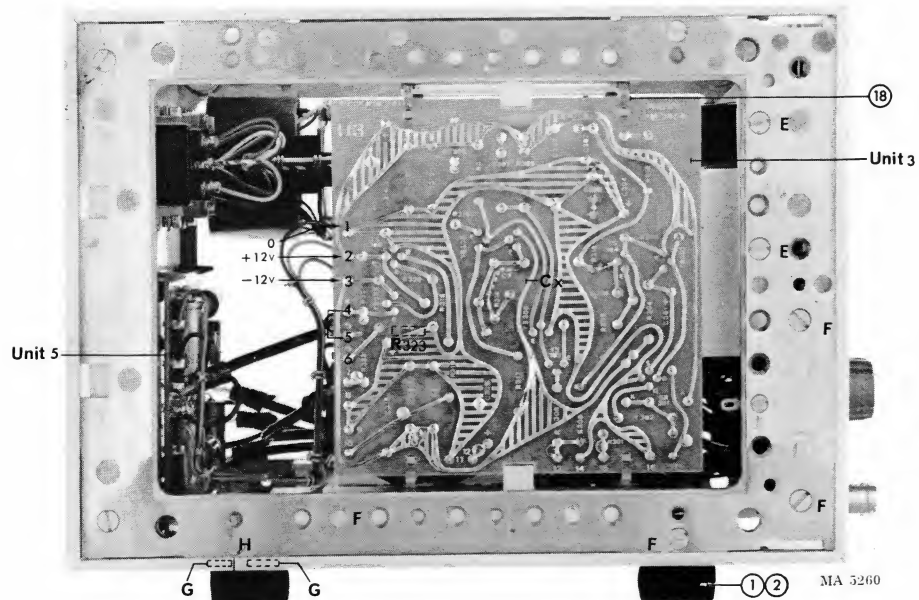


Fig. 13 Left-hand view

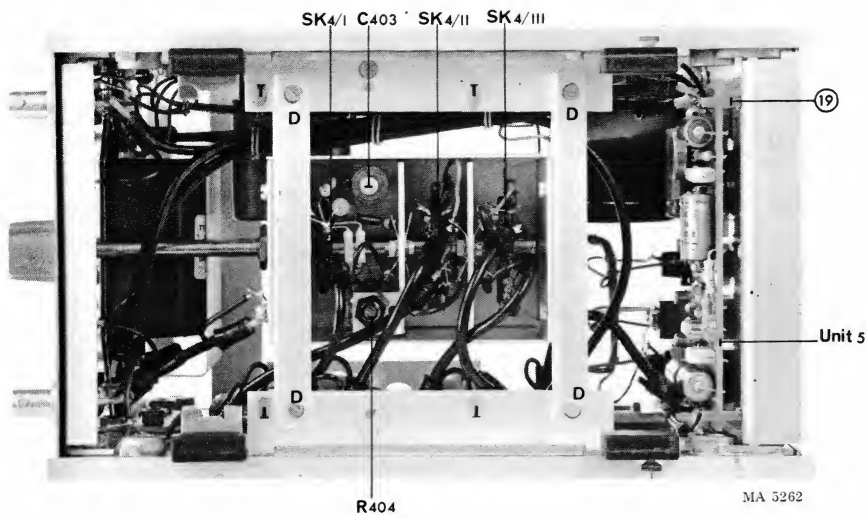


Fig. 14 Bottom view

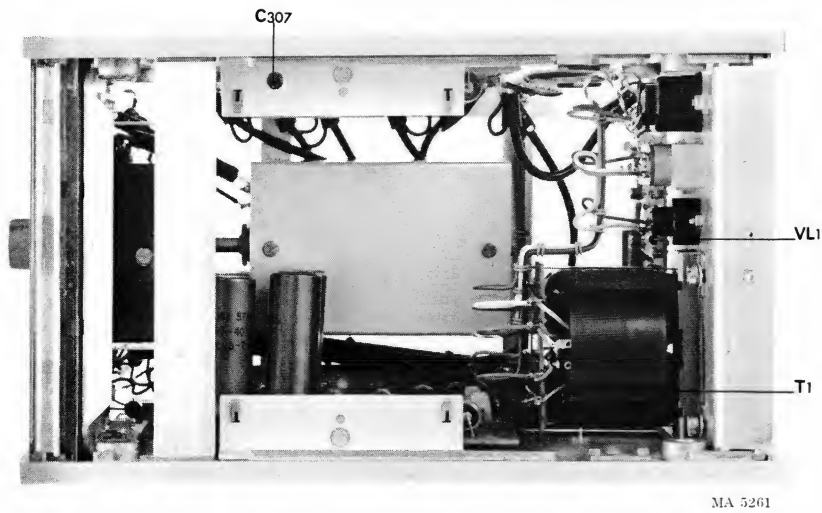


Fig. 15 Top view

B. ELECTRICAL — ELEKTRISCH — ELEKTRISCH — ELECTRIQUE — ELECTRICOS




















This parts list does not contain multi-purpose and standard parts. These components are indicated in the circuit diagram by means of identification marks. The specification can be derived from the survey below.

Diese Ersatzteilliste enthält keine Universal- und Standard-Teile. Diese sind im jeweiligen Prinzipschaltbild mit Kennzeichnungen versehen. Die Spezifikation kann aus nachstehender Übersicht abgeleitet werden.

In deze stuklijst zijn geen universele en standaardonderdelen opgenomen. Deze componenten zijn in het prinsipschema met een merkteken aangegeven. De specificatie van deze merktekens is hieronder vermeld.

La présente liste ne contient pas des pièces universelles et standard. Celles-ci ont été repérées dans le schéma de principe. Leurs spécifications sont indiquées ci-dessous.

Esta lista de componentes no comprende componentes universales ni standard. Estos componentes están provistos en el esquema de principio de una marca. El significado de estas marcas se indica a continuación.

| | | | |
|--|--|--|---|
|  Carbon resistor E24 series Kohleschichtwiderstand, Reihe E24 Koolweerstand E24 reeks Résistance au carbone, série E24 Resistencia de carbón, serie E24 | $0,125\text{ W}$ 5% |  Carbon resistor E12 series Kohleschichtwiderstand, Reihe E12 Koolweerstand E12 reeks Résistance au carbone, série E12 Resistencia de carbón, serie E12 | 1 W $\leq 2,2\text{ M}\Omega$, 5% $> 2,2\text{ M}\Omega$, 10% |
|  Carbon resistor E12 series Kohleschichtwiderstand, Reihe E12 Koolweerstand E12 reeks Résistance au carbone, série E12 Resistencia de carbón, serie E12 | $0,25\text{ W}$ $\leq 1\text{ M}\Omega$, 5% $> 1\text{ M}\Omega$, 10% |  Carbon resistor E12 series Kohleschichtwiderstand, Reihe E12 Koolweerstand E12 reeks Résistance au carbone, série E12 Resistencia de carbón, serie E12 | 2 W 5% |
|  Carbon resistor E24 series Kohleschichtwiderstand, Reihe E24 Koolweerstand E24 reeks Résistance au carbone, série E24 Resistencia de carbón, serie E24 | $0,5\text{ W}$ $\leq 5\text{ M}\Omega$, 1% $> 5\text{ M}\Omega$, 2% $> 10\text{ M}\Omega$, 5% |  Wire-wound resistor Drahtwiderstand Draadgewonden weerstand Résistance bobinée Resistencia bobinada | $0,4 - 1,8\text{ W}$ 0,5% |
|  Carbon resistor E12 series Kohleschichtwiderstand, Reihe E12 Koolweerstand E12 reeks Résistance au carbone, série E12 Resistencia de carbón, serie E12 | $0,5\text{ W}$ $\leq 1,5\text{ M}\Omega$, 5% $> 1,5\text{ M}\Omega$, 10% |  Wire-wound resistor Drahtwiderstand Draadgewonden weerstand Résistance bobinée Resistencia bobinada | $5,5\text{ W}$ $\leq 200\ \Omega$, 10% $> 200\ \Omega$, 5% |
|  Wire-wound resistor Drahtwiderstand Draadgewonden weerstand Résistance bobinée Resistencia bobinada | 10 W 5% | | |
|  Tubular ceramic capacitor Rohrkondensator Keramische kondensator, buistype Condensateur céramique tubulaire Condensador cerámico tubular | 500 V |  Polyester capacitor Polyesterkondensator Polyesterkondensator Condensateur au polyester Condensador polyester | 400 V |
|  Tubular ceramic capacitor Rohrkondensator Keramische kondensator, buistype Condensateur céramique tubulaire Condensador cerámico tubular | 700 V |  Flat-foil polyester capacitor Miniatur-Polyesterkondensator (flach) Platte miniatur polyesterkondensator Condensateur au polyester, type plat Condensador polyester, tipo de placas planas | 250 V |
|  Ceramic capacitor, "pin-up" Keramikkondensator "Pin-up" (Perlyp) Keramische kondensator "Pin-up" type Condensateur céramique, type perle Condensador cerámico, versión "colgable" | 500 V |  Paper capacitor Papierkondensator Papierkondensator Condensateur au papier Condensador de papel | 1000 V |
|  "Microplate" ceramic capacitor Miniatur-Scheibenkondensator "Microplate" keramische kondensator Condensateur céramique "microplate" Condensador cerámico "microplaca" | 30 V |  Wire-wound trimmer Drahttrimmer Draadgewonden trimmer Trimmer à fil Trimmer bobinado | |
|  Mica capacitor Glimmerkondensator Micakondensator Condensateur au mica Condensador de mica | 500 V |  Tubular ceramic trimmer Rohrtrimmer Buisvormige keramische trimmer Trimmer céramique tubulaire Trimmer cerámico tubular | |



For multi-purpose and standard parts, please see PHILIPS' Service Catalogue.

Für die Universal- und Standard-Teile siehe den PHILIPS Service-Katalog.

Voor universele en standaardonderdelen raadplege men de PHILIPS Service Catalogus.

Pour les pièces universelles et standard veuillez consulter le Catalogue Service PHILIPS.

Para piezas universales y standard consulte el Catálogo de Servicio PHILIPS.

| No. | Ordering code | Value | Tolerance (%) | Voltage (V) | Description |
|------|----------------|-------------|---------------|-------------|-------------------------|
| C201 | 4822 124 40092 | 320 μ F | | 40 | Electrolytic |
| C202 | 4822 124 40092 | 320 μ F | | 40 | |
| C203 | 4822 124 40012 | 500 μ F | | 35 | |
| C204 | 4822 124 40012 | 500 μ F | | 35 | |
| C207 | 4822 124 20403 | 400 μ F | | 10 | |
| C208 | 4822 124 20403 | 400 μ F | | 10 | |
| C209 | 4822 124 20414 | 640 μ F | | 6.4 | |
| C210 | 4822 124 20414 | 640 μ F | | 6.4 | |
| C211 | 4822 124 20366 | 32 μ F | | 16 | |
| C212 | 4822 124 20366 | 32 μ F | | 16 | |
| C213 | 4822 121 40036 | 0.1 μ F | 10 | 250 | Polyester |
| C214 | 4822 121 40036 | 0.1 μ F | 10 | 250 | Polyester |
| C301 | 4822 124 10076 | 150 μ F | | 15 | Electrolytic |
| C304 | 4822 124 10081 | 330 μ F | | 6 | Electrolytic |
| C307 | 4822 125 60027 | 6 pF | | | Ceramic tubular trimmer |
| C309 | 4822 124 20398 | 250 μ F | | 6.4 | Electrolytic |
| C314 | 4822 124 20394 | 160 μ F | | 25 | Electrolytic |
| C315 | 4822 124 20394 | 160 μ F | | 25 | Electrolytic |
| C315 | 4822 124 20394 | 160 μ F | | 25 | Electrolytic |
| C316 | 4822 124 20387 | 150 μ F | | 6.4 | Electrolytic |
| C403 | 4822 125 60031 | 25 pF | | | Air trimmer |
| C405 | 4822 120 60115 | 2 nF | 1 | 125 | Polyester |
| C501 | 4822 124 20394 | 160 μ F | | 25 | Electrolytic |
| C503 | 4822 124 20394 | 160 μ F | | 25 | |
| C506 | 4822 124 20374 | 50 μ F | | 10 | |
| C507 | 4822 124 20374 | 50 μ F | | 10 | |
| C508 | 4822 124 20414 | 640 μ F | | 6.4 | |
| C511 | 4822 124 20383 | 100 μ F | | 10 | |

Resistors

| No. | Ordering code | Value | Tolerance (%) | Power (W) | Description |
|------|----------------|----------------|---------------|-----------|---------------------|
| R1 | 4822 112 20103 | 680 Ω | 5 | 5.5 | Wire-wound |
| R324 | 5322 111 40189 | 10 M Ω | 1 | | Potentiometer, Lin. |
| R401 | 5322 111 40189 | 10 M Ω | 1 | | |
| R404 | 4822 101 20074 | 2.2 k Ω | | | |
| R411 | 4822 113 40089 | 1 k Ω | $\frac{1}{4}$ | 0.6 | |
| R412 | 4822 113 10024 | 320 Ω | $\frac{1}{4}$ | 0.4 | |
| R414 | 4822 113 10046 | 100 Ω | $\frac{1}{4}$ | 0.4 | |
| R415 | 4822 113 10133 | 46.4 Ω | $\frac{1}{4}$ | 0.4 | Measuring resistor |
| R421 | 4822 113 40089 | 1 k Ω | $\frac{1}{4}$ | 0.6 | |
| R422 | 4822 113 10024 | 320 Ω | $\frac{1}{4}$ | 0.4 | |
| R424 | 4822 113 10046 | 100 Ω | $\frac{1}{4}$ | 0.4 | |
| R425 | 4822 113 10133 | 46.4 Ω | $\frac{1}{4}$ | 0.4 | |
| R510 | 4822 101 20003 | 10 k Ω | | | Potentiometer, Lin. |

Miscellaneous

| Fig. | Item | Quantity | Ordering code | Description |
|------|------|----------|----------------|---|
| 18 | L501 | 1 | 4822 158 10222 | Coil |
| 15 | T1 | 1 | 4822 145 40102 | Mains transformer |
| 15 | VL1 | 1 | 4822 253 30012 | Fuse, 200 mA, delayed-action |
| 15 | VL2 | 1 | 4822 252 20001 | Thermal fuse |
| 12 | | 1 | 4822 216 70102 | Printed circuit board, with components (unit U2) |
| 13 | | 1 | 5322 216 74001 | Printed circuit board, with components (unit U3) |
| 14 | | 1 | 4822 216 70104 | Printed circuit board, with components (unit U5) |

SEMI-CONDUCTORS

Diodes

| No. | Order number | Type | |
|-------|----------------|-------------------------|-------|
| GR201 | 4822 130 30521 | BY179 | |
| GR202 | 4822 130 30079 | BZY88-C6V8 ^x | Zener |
| GR203 | 4822 130 30079 | BZY88-C6V8 ^x | Zener |
| GR301 | 4822 130 30594 | BAV10 | |
| GR302 | 4822 130 30594 | BAV10 | |
| GR303 | 4822 130 30079 | BZY88-C6V8 ^x | Zener |
| GR501 | 4822 130 30323 | IN4009 ^{xx} | |
| GR502 | 4822 130 30084 | AAZ18 | |
| GR503 | 4822 130 30323 | IN4009 ^{xx} | |
| GR504 | 4822 130 30287 | BZY88-C7V5 ^x | Zener |
| GR505 | 4822 130 30287 | BZY88-C7V5 ^x | Zener |
| GR506 | 4822 130 30084 | AAZ18 | |

Transistors

| | | | |
|-------|----------------|--------|--|
| TS201 | 4822 130 40332 | BC107B | |
| TS202 | 4822 130 40332 | BC107B | |
| TS203 | 4822 130 40343 | BC108B | |
| TS204 | 4822 130 40353 | BC179 | |
| TS205 | 4822 130 40353 | BC179 | |
| TS206 | 4822 130 40332 | BC107B | |
| TS301 | 4822 130 40408 | BFW11 | (can be replaced by BFW10, order number 4822 130 40443) |
| TS302 | 4822 130 40353 | BC179 | |
| TS303 | 4822 130 40343 | BC108B | |
| TS304 | 4822 130 40343 | BC108B | |

^x Can be replaced by type BZX79-C6V8

^{xx} Can be replaced by type BAW62 (5322 130 30613)

^{xxx} Can be replaced by type BZX79-C7V5 (4822 130 30666)

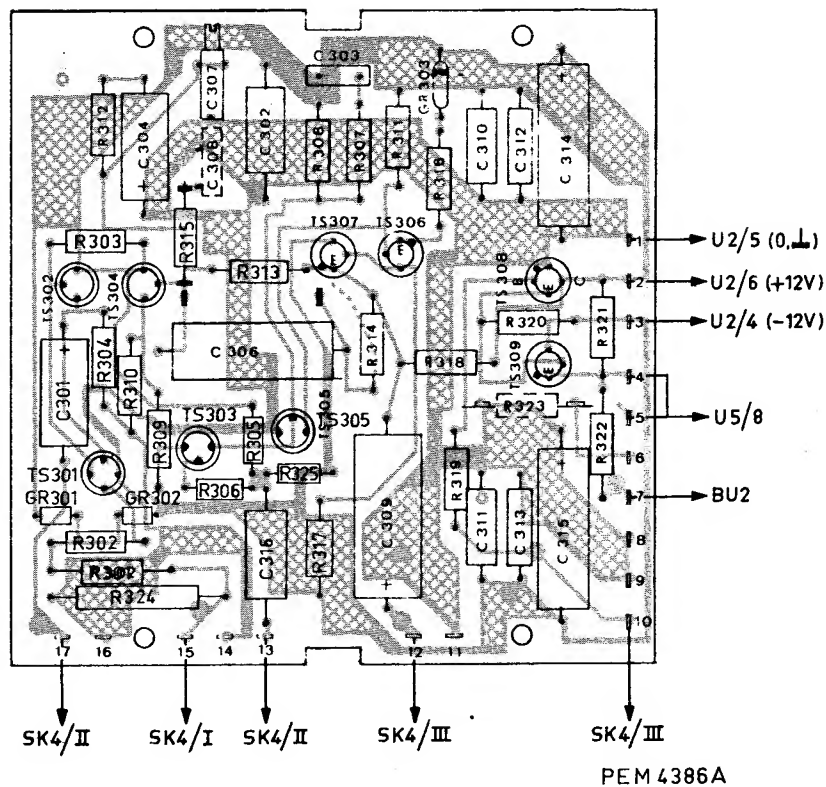


Fig. 17 Printed circuit board U3

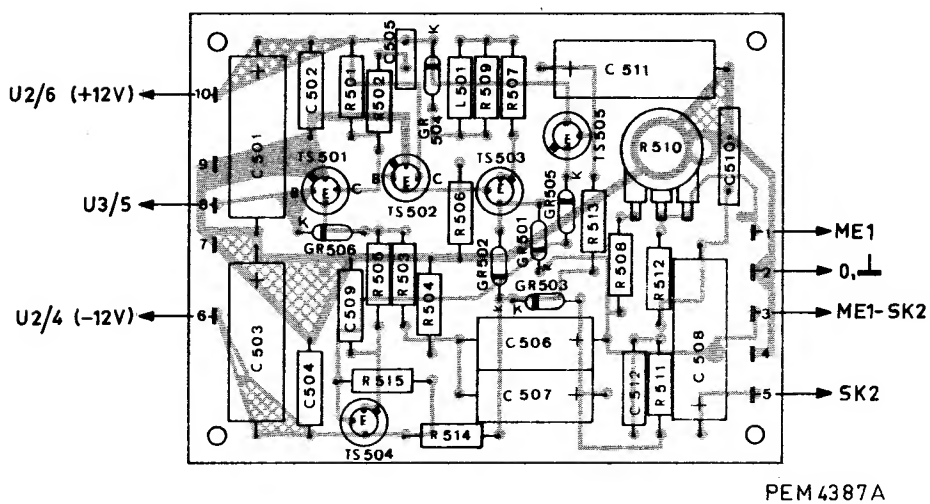


Fig. 18 Printed circuit board U5

